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# LISFRANC FRACTURE-DISLOCATION IN A FEMALE SOCCER ATHLETE

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## ABSTRACT

Individuals with midfoot injuries may present to physical therapists in a variety of clinical settings. The ability of the physical therapy practitioner to optimally manage the care of such an individual may be dependent on understanding the diagnostic imaging that is indicated or has been been completed. Among the potentially most debilitating midfoot injuries are Lisfranc fracture-dislocations. This case outlines the use of conventional radiology, standard computerized tomography (CT), and three-dimensional CT for differential diagnosis of Lisfranc and associated midfoot injury in a 26 year-old female recreational athlete. Her subsequent surgical and post-surgical management is briefly discussed.

Physical therapists evaluating patients with suspected midfoot injuries should be cognizant of the tendency for Lisfranc injuries to escape initial detection, possibly precipitating misdiagnosis or delay to diagnosis. Non-weight-bearing radiography may be insensitive to demonstrating the anatomical disruption of significant midfoot injuries. Weight-bearing radiographic views along with selective use of MRI and CT aid in proper identification of injury to the tarsometatarsal joints and optimal management of patients with these injuries.

***Key words:*** diagnostic imaging, Lisfranc injury, midfoot injury

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## INTRODUCTION

Individuals with midfoot injuries may present to physical therapists in a variety of clinical settings. The ability of the physical therapy practitioner to optimally manage the care of such an individual may be dependent on understanding the diagnostic imaging that is indicated or has been been completed. Among the potentially most debilitating midfoot injuries are Lisfranc fracture-dislocations. Lisfranc fracture-dislocations are an uncommon, but serious injury occurring as a result of trauma to the tarsometatarsal articulations of the midfoot.[1,2] The historical basis for the eponym has been described as originating with French surgeon Jacques Lisfranc de St. Martin. Lisfranc reported on midfoot injuries when calvarymen would fall from their horses with a foot remaining plantar flexed in the stirrup during Napoleon Bonaparte's military campaigns.[3] Similarly, Lisfranc also described the midfoot amputation he pioneered.[4,5]

In present day athletes, midfoot injuries, including Lisfranc fracture-dislocations, have been observed to occur from forced plantar flexion or abduction of the forefoot in open and closed chain conditions.[4,5] Another causative circumstance can occur with an axial force driven downward through the calcaneus while the foot is plantarflexed.[3,6] Other high impact trauma events, as has been reported in motor vehicle accidents or in industrial settings, can result in direct crushing type injuries to the tarsometatarsal joints[2,7] and numerous other mechanisms exist in sport specific situations.[6]

### Clinical Presentation

The patient in this case report was a 26 year-old female, who regularly participated in a recreational indoor soccer league and also ran competitively, including marathon events. During a soccer game, she was kicked by another athlete directly on the bottom of her soccer shoe with the immediate onset of severe foot pain and a subsequent inability to weight-bear. The athlete, who is a physical therapist, described the transverse and longitudinal arches of her foot collapsing.

She received emergent evaluation and care, including radiography of her injured foot. In her case, radiography revealed significant osseoligamentous injury of her foot. The standard radiologic examination was supplemented by standard computed tomography (CT) and three-dimensional CT because of the need for further description of the pathology and surgical planning. The accompanying images reveal multiple fractures along the tarsometatarsal joints along with suggestions of ligamentous instability (Figures 1-8).

**Figure 1.** *A-P Radiograph of the Foot (Nonweight-bearing). Note the disruption of anatomical alignment at the tarsometatarsal joints indicated within the circle. The apparent distortion of the foot length is because of the foot being plantarflexed during image capture. Thus, the forefoot is not at 90 degrees to the x-ray tube. This suboptimal positioning was the result of the patient's intolerance to standard positioning protocol.*

### Evaluation and Diagnostic Imaging

The American College of Radiology Appropriateness Criteria[8] for the patient with traumatic foot injury incorporates the predictors of the Ottawa Ankle and Foot Rules, suggesting the most contributory imaging for best decision making toward management of the patient's care. The Ottawa Rules suggest standard three-view radiography of foot if there is tenderness to palpation of the navicular or fifth metatarsal or if the patient has an inability to weight-bear.

The clinical suspicion of a Lisfranc injury, however, can influence the imaging modality selection and

**Figure 2.** *Enlargement of the Tarsometatarsal Joints. Note the fractures and malalignment at the bases of the second through fourth metatarsals and the increased space between the medial and intermediate cuneiforms.*

methodology. Under Variant 1, in which the Ottawa Rules are met, the initial studies recommended are radiographs. Under Variant 4, with clinical suspicion of significant midfoot injury, radiography is recommended and with weight-bearing views, even if the patient is negative on the Ottawa Rules[8] Weight-bearing views have been shown to increase the abnormal alignment at the first intermetatarsal space, thus making the identification of a Lisfranc injury easier.[9]

Most frequently, nonweight-bearing three-view radiographs are the initial imaging studies performed in the case of traumatic foot injury. Fractures and malalignments may be adequately demonstrated on standard anterior-posterior (A-P), internal oblique, and lateral view nonweight-bearing radiography, as occurred in this case (Figures 1-4). Lisfranc injuries, however, often have subtle findings which may escape initial radiographic assessment. The absence of weight-bearing views can lower the diagnostic accuracy of radiography.[2,5]

The lack of valid radiographic results or their misinterpretation are likely contributors to the mismanagement of those with Lisfranc injuries. Multiple studies[10-12] cite initial misdiagnosis or delay to diagnosis occurring in 20-40% of Lisfranc injuries.

Clinical examination findings that particularly elevate the suspicion for Lisfranc injury include a


**Figure 3.** *Oblique Radiograph of the Foot. Note the fractures across the second through fourth metatarsal bases, indicated within the circle.*

**Figure 4.** *Enlargement of the Oblique View. The fractures are more clearly demonstrated in this enlarged image.*

**Figure 5.** *Three-Dimensional CT Image of the Dorsum of the Bony Foot. The malalignment at the bases of the second through fourth metatarsals is evident in this image.*

**Figure 6.** *Three-Dimensional CT Image of the Plantar Surface of the Bony Foot. The fractures at the bases of the second through fourth metatarsals are demonstrated.*

grossly edematous foot in which passive abduction and pronation are particularly provocative of foot pain. Additionally, the presence of ecchymosis on the plantar aspect of the foot has been reported to be an indicator of significant midfoot injury.[2,4,13] Myerson et al.[2] report a clinical stress test consisting of squeezing the first and second metatarsal interspace in the coronal plane to stress the base of the middle and the medial column in an attempt to elicit pain or a palpable click. This clinical exam procedure, however, has yet to be standardized and validated. To further enhance radiographic detection, stress views of the foot with passively applied pronation and abduction in combination has been suggested.[5] This procedure, also, has yet to be validated and is not yet incorporated into the American College of Radiology Appropriateness Criteria.

In the case of persistent clinical suspicion of a Lisfranc injury, even in the presence of normal radiographs or indeterminate study interpretations, or if the patient is intolerant of weight-bearing radiographs, MRI and/or CT are indicated as the next imaging studies.[8] Both studies may be warranted, given the potential for structural compromise of the bony elements and the ligaments spanning the joints. The superior capacity of MRI to depict the ligamentous tissues allows for excellent detection of midfoot injury, including those radiographically occult lesions.[5,14,15] CT may also be

**Figure 7.** *Enlargement of the Three-Dimensional CT Image of the Tarsometatarsal Joints. Further detail is revealed of the fractures of the second through fourth metatarsal bases.*

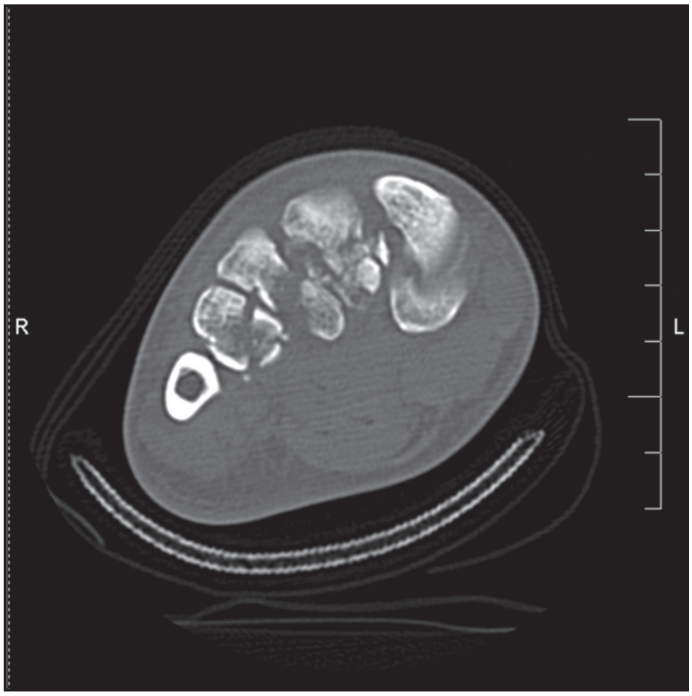


**Figure 8.** *A Conventional CT Coronal Reconstruction through the Tarsometatarsal Region. The fracture lines are clearly delineated and the extent of displacement of the fracture fragments is revealed in this image.*

used because of its excellent ability to detect disruption of cortical bone.[4,5] In the case of this particular patient, standard CT and three-dimensional CT images allowed for further appreciation of the detail of the fractures and malalignment across the tarsometatarsal joints, most notably between the intermediate and lateral cuneiforms, cuboid, and the second through fourth metatarsals (Figures 5-8).

**Management Process**

The patient immediately underwent open reduction internal fixation with percutaneous pinning to restore anatomical alignment and stabilize the tarsometatarsal joints. Her foot was immobilized post-operatively and her ambulatory status was designated as non-weight-bearing for 12 weeks. The extent of weight-bearing restriction is typically a function of the severity of the injury and the complexity of the reconstructive procedure with six weeks of nonweight-bearing being common.[2,16] The return to weight-bearing is typically based on additional radiographic evidence of fracture healing.[4] Physical therapy interventions during the maximum protection phase included screening for venous thromboembolism, management of pain and edema, and gait training with crutches and a Roll-A-Bout™. She also completed an exercise program directed at maintaining the hip and knee musculature of the affected lower extremity.

After the maximum protection phase, physical therapy interventions were aimed at restoring mobility and strength in the lower limb. This included manual mobilization of the talocrural and substalar joints. The patient was able to progress from wearing a cam walking boot to athletic shoes with routine ambulatory activity. Shoes providing minimal support were generally avoided because of reports of pain when walking. Pain continued to be a limiting factor during her rehabilitation progression from the elliptical exercise device and bicycle to running on a treadmill. This was addressed with semi-rigid custom-fit orthotics, which resulted in an increased tolerance to running. Her conditioning toward returning to recreational running was enhanced by running in a swimming pool and transitioning to a treadmill. She specifically avoided cutting activities or running on grass or sand because return to these activities is usually deferred until late in the rehabilitation process, typically four months after surgical repair.[2,4]

Although not a factor in this patient, complications have been reported to occur in patients having Lisfranc injuries. Most notable in the immediate post-injury period is the occurrence of compartment

syndromes.[4,5,13] Practitioners must be vigilant to recognize any indication of neurovascular compromise due to the potentially catastrophic consequences that might occur if not appropriately treated. Later occurring complications include malunion, nerve irritation, and complex regional pain syndrome.[2,4,17] A frequent long-term result, particularly in those undergoing open reduction and internal fixation of Lisfranc injuries, is post-traumatic arthrosis.[4,18,19] In such cases, primary arthrodesis is often chosen to maximize functional mobility.[2,19,20]

**Outcomes**

Customarily, athletes that undergo surgical fixation of a Lisfranc fracture-dislocation should expect to be sidelined for 12 to 16 weeks. Often, return to sport is based on the symptoms of the individual and the sport to which the athlete is attempting to return. For higher impact sports and those requiring rapid directional changes, this particular injury may be career ending for the athlete.[2,6]

At the 16 week reassessment, the patient continued to demonstrate limitations in strength and mobility of her foot and ankle. Although motivated to begin running again, she continued to have pain with higher impact weight bearing activities. Her daily level of pain was largely dependent on her level of activity and footwear. She reported pain levels of four of 10 on a numerical pain scale at the end of her workday in unsupportive shoes, but only one of 10 when wearing athletic shoes. Her greatest level of pain during the rehabilitative phase was rated at seven of 10, subsequent to wearing high-heeled shoes.

Approaching the six month mark after injury, her strength and range of motion were approaching that of her uninvolved side. Her activity tolerance, including running, accelerated after initiating the wear of the custom-fit orthotic devices. She returned to running outdoors and completed a half marathon approximately six months after the injury.

**Recommendation**

Physical therapists evaluating patients with suspected midfoot injuries should be cognizant of the tendency for Lisfranc injuries to escape initial detection, possibly precipitating misdiagnosis or delay to diagnosis. Nonweight-bearing radiography may be insensitive to demonstrating the anatomical disruption of significant midfoot injuries. Weight-bearing radiographic views along with selective use of MRI and CT aid in proper identification of injury to the tarsometatarsal joints and optimal management of patient care. Those patients who demonstrate plantar ecchymosis, have pain provoked with passive foot abduction or pronation, or have pain elicited with manual approximation of the first and second metatarsals in the coronal plane warrant particular suspicion for Lisfranc injury and may need additional imaging for complete diagnosis.

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